CatGold NEWS

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A newsletter on developments and progress in gold catalysis and its applications

Noble Cause: Modern Gold and Platinum Group Catalysis

A one day meeting on this topic will take place at SCI, London on Wednesday April 16. The ability of gold and PGM catalysts to effect powerful and atom-economic transformations has led to a marked increase in their utilization for organic synthesis and recent progress will be reviewed by six leading researchers from Europe and the USA. The programme will include talks entitled 'Molecular Gold Catalysts for Organic Synthesis' by Prof Stephen Hashmi, Heidelberg University, Germany, 'Gold, An Old Metal for New Chemistry' by Dr Fabian Gagosz, Ecole Polytechnique, Palaiseau, France, 'Gold-Catalysed Skeletal Rearrangement of Enynes and Beyond' by Prof Antonio Echavarren, ICIQ, Tarragona, Spain and 'Gold(I) Catalysts for Organic Synthesis: Development, Applications and Enantioselective Catalysis' by Prof Dean Toste, University of California, Berkeley, USA. Further details are available on www.soci.org where registration can be made. ■

CatGold News is available at www.goldbulletin.org

WORLD GOLD COUNCIL

Partnership to Develop New Market for Gold-Based Emission Control Technology

World Gold Council (WGC) and Nanostellar Inc, a leading-edge developer of emission control technologies, have agreed to a long-term strategic partnership to enable the introduction of gold into the autocatalyst market. Under the terms of the agreement, World Gold Council has invested in Nanostellar Inc in order to facilitate the commercialisation and marketing of the gold-based technology that could increase industrial demand for gold.

Nanostellar has developed a new product, NS Gold™, a catalyst formulation for use in the automotive industry that for the first time includes gold alongside traditional platinum and palladium metals. The inclusion of gold enables manufacturers of light- and heavy-duty diesel engines to reduce noxious emissions by as much as 40% more than existing pure platinum catalysts, enabling significant savings for automotive manufacturers. The potential to use gold in this type of application has long been considered, but until now the technical challenges concerning catalyst durability have prevented gold's use. Independent test results confirm Nanostellar's breakthrough which, if adopted by the automotive industry, could lead to an increase in industrial demand for gold, which in 2006 totaled 16.1 million oz (458 tonnes).

According to Johnson Matthey, during 2007, 4.24 million oz. (119 tonnes) of platinum is expected to be used in automotive catalysts – an increase of 2.3 percent from 2006. In recent years, Nanostellar and other producers of catalyst materials have introduced the use of palladium to partially replace the four-times more expensive platinum. Now, to further reduce the amount of platinum needed and the overall cost of the catalysts, Nanostellar has pioneered the use of gold — which is nearly half the price of platinum — for diesel emission control.

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Joining Nanostellar's existing equity investors, which include 3i, Khosla Ventures and Monitor Ventures, among others, WGC will also provide the company with significant marketing and business development support, designed to increase uptake of NS Gold among the global vehicle manufacturing community.

James Burton, CEO of the World Gold Council, commented: "World Gold Council is delighted to be able to assist Nanostellar in its efforts to bring the first gold-containing autocatalyst products to the market. The autocatalyst market is a large and important one for the platinum group metal producers and we are excited to be entering this new arena. We are also pleased to see gold play a role in an application with undoubted environmental benefits."

Pankaj Dhingra, CEO of Nanostellar Inc, commented: "Garnering the support of a globally respected organisation like the World Gold Council speaks volumes about our proven technology and large market opportunity. WGC's marketing expertise coupled with our technical knowledge should prove a powerful combination in winning advocates for our new product." ■

Most Accessed Article

The comprehensive review entitled 'Gold-Catalysed Organic Reactions' written by A Stephen K Hashmi (University of Heidelberg, Germany) covering the literature on this theme up until October 2006 and published in *Chemical Reviews*, 2007, 107, 3180 – 3211, has been featured as a Most-Accessed Article for the third-quarter of 2007. Most-Accessed Articles listed are based on article web view data collected following COUNTER-compliant ACS Usage Reports [http://pubs.acs.org/journals/promo/most/most_accessed/index.html] ■

People Profile:

Prof Caixia Qi

Institute of Applied Catalysis, Department of Chemistry and Biology, Yantai University, Shandong, China

Caixia Qi studied chemistry related to the preparation of supported precious metals catalysts for the complete oxidation of methane and received her Ph.D degree in 1996 when she was at the Chinese Academy of Sciences (CAS). Then she worked on nanoparticulate gold catalysts for the epoxidation of propene at the Osaka National Research Institute from 1999 to 2001 under the direction of Professor Masatake Haruta where she was awarded a postdoctorial fellowship by the Science and Technology Agency of Japan. Working on a set of modified mesoporous Ti-MCM-41 catalysts, she found that very low Au loadings (≤0.02wt.%) produced catalysts which were very active in terms of per gram of Au with good stability for about 7 hours after a 30 minutes induction period. PO selectivity was greater than 80% at a temperature as high as 250ºC over the silylated Ti-MCM-48 supported Au catalysts.

When she moved to the Royal Military College of Canada, where she worked under the guidance of Professor Brant A Peppley and John C Amphlett for a few years, her research topic was steam reforming of alcohols. In 2006, she was appointed as a professor by Yantai University, China and joined the Institute of Applied Catalysis. The institute was founded by Professor Lidun An in 1996, who has been involved in Au catalysis research, mainly in applications for air purification via low temperature CO oxidation, since 1992. The good performance of their model catalyst YD-2 has been demonstrated successfully for use in gas masks and they are investigating other specific applications with domestic industrial end-users.

Currently, Caixia Qi is a professor at Yantai University and a visiting researcher in Professor Haruta's laboratory at Tokyo Metropolitan University. She is involved in further improving the stability of Au catalysts on exposure in air and pursuing opportunities for their industrial application in collaboration with Professor An and Associate Professor Shixue Qi and others. Her research interests also include propene epoxidation, catalytic cracking of hydrocarbons and hydrogen production from biogas. In her interests outside science, Caixia enjoys swimming, reading, and traveling with her husband, a son of 10 and a daughter of 3 years old.

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Gold Catalysts used to Transform Biomass Feedstocks

1 Results from Lyngby, Denmark

Petroleum-based feedstocks continue to become more expensive, and consequently chemists are being challenged to devise processes that utilize biomass-derived feedstocks. In one of the latest developments, Claus H Christensen and co-workers of the Center for Sustainable and Green Chemistry at the Technical University of Denmark, in Lyngby, have described a gold-catalysed procedure for selective oxidation of the biomass-derived platform chemicals furfural and hydroxymethylfurfural to form their respective methyl esters (SK Ritter, Chem and Eng News, Jan 3 2008; E Taarning, IS Nielsen, K Egeblad, R Madsen and CH Christensen, ChemSusChem, in press DOI: 10.1002/cssc200700033). Platform molecules are envisaged as key building blocks for the future chemical industry based on renewable chemicals, and methods are being sought to convert biomass into these key chemicals.

Hydroxymethylfurfural (HMF) derived from biomass can be selectively oxidized to furandimethylcarboxylate (FDMC) using Au/TiO_2 catalyst in methanol in the presence of 8% sodium methoxide under 4 bar O_2 at 130°C to give FDMC in 98% yield in 3 h :

This efficient conversion is a good example of the potential of gold catalysis to produce useful chemicals from biomass-derived starting materials. Methyl furoate formed from furfural is useful for avour and fragrance applications and has potential as an industrial solvent. FDMC derived from HMF is a monomer that could replace the terephthalic acid used for making polyester plastics.

The course of the reaction is quite different from when a platinum catalyst is used: platinum gives furan dicarbaldehyde in the Pt-catalysed oxidation of HMF in water.

Prof Claus Christensen, who is funded by the Danish National Advanced Technology Foundation says that "There is a great future for producing value-added chemicals from biomass, and it will most likely require intimate integration of biocatalytic and heterogeneous catalytic processes in order to achieve cost-competitive processes that are also environmentally friendly".

Just as heterogeneous catalysis can be used to convert petroleum-derived feedstocks into many useful fuels and chemicals, Christensen's group is helping to show that heterogeneous catalysis can be used to convert carbohydrate-based feedstocks into fuels and chemicals by selective oxidation reactions.

2 New Project at Imperial College London

A new project entitled 'Designing catalysts for the utilization of biorenewable feedstocks' is starting at Imperial College, London, see:

http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/E009999/1

This is being led by Prof David Chadwick and focuses on the use of Au-Pd catalysts, as recently developed at Cardiff University by Prof Graham Hutchings' group for hydrogen peroxide synthesis and selective oxidation reactions. The aim is to design gold catalysts that can be used as a standard synthetic methodology and to show that these catalysts can be used for the selective oxidation of sugars and terpenes. ■